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Organic Farming Based on Participatory Guarantee Systems: Exploring Economic Performance of Farmers in the Northern Delta Provinces of Vietnam

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Faculty of Economics, Tay Nguyen University, 567 Le Duan Street, Buon Ma Thuot City, Dak Lak Province, Vietnam. The study aims to evaluate the economic performance of Participatory Guarantee Systems (PGS) in certifying organic vegetable farmers in Northern Vietnam. Moreover, this study identifies the differentiation between prosperous and non-prosperous farmers by analyzing critical factors associated with farm management. With a multi-stage cluster sampling technique, the data were collected from three provinces in Northern Vietnam between March and April, 2023. The findings indicate that PGS farming has the potential to be more efficient than conventional farming, mainly due to reduced intermediate costs and access to niche markets. However, PGS farms are more labor-intensive due to their reliance on manual practices. In addition, the selling approaches and technical progress significantly impact economic viability. These findings highlighted the need to develop market access and enhance farmers' confidence in sustainable agricultural practices to advise the competitiveness of PGS farms.
Keywords: Determinants, economic performance, participatory guarantee systems, organic farms, labor cost, market access, Vietnam.

INTRODUCTION

The agricultural sector is essential to Southeast Asian countries' economic growth and development (Vos 2018). This sector is a crucial driver for poverty alleviation in this region. That is why the increase in agricultural productivity is the government's primary concern (Mishra *et al*., 2020). However, in practice, an increase in agricultural productivity seems to lead to fast environmental degradation because of the increased use of natural resources (fertilizer, water, electricity) (Aryal *et al*., 2020). Therefore, another solution has been to pay more attention by increasing yield, providing high-quality food, and minimizing the ecological footprint of agriculture, which need to be considered global challenges. In other words, sustainable production practices by addressing environmental issues, food, and nutrient security, and livelihood are essential for worldwide agriculture (FAO, 2019; Kerr *et al*., 2021; Van der Ploeg *et al*., 2019; Wezel *et al*., 2020). Previous studies implied that conventional approaches often focus heavily on mechanical, chemical, and other resources such as irrigation, pesticides, fertilizers, and herbicides. It is implied that traditional approaches seem to lead the farmers to target productivity improvement. On the contrary, many authors showed the impacts of sustainability standards, including organic agriculture, have spread widely and received more attention, such as the potential to enhance livelihood opportunities, increase income for resource-poor small-scale farmers, provide rural development benefits (Grovermann *et al*., 2021; Schleifer *et al*., 2020). It has, therefore, become a popular strategy for economic development and poverty alleviation in many regions (Ayuya *et al*., 2015; Lobley *et al*., 2009; Qiao *et al*., 2016; Schader *et al*., 2021; Zhen *et al*., 2023). Participatory Guarantee Systems (PGS) are "community-based quality assurance systems" that employ organic verification through a "foundation of trust, social networks, and knowledge sharing" (IFOAM, 2018). PGS initiatives leverage peer-review assessments to conduct organic verification procedures while fostering active stakeholder involvement, social conformity, and trust (Hruschka *et al*., Vogl, 2022; Kaufmann and Vogl, 2018).

In Vietnam, PGS certification exists alongside a variety of international third-party standards (like USDA and JAS) as well as the public third-party organic standard (TCVN 11041-1 issued in 2017). Vietnam's national food system action plan specifies a target of 2.5 - 3% organic area and a 30% organic fertilizer share by 2030 (Decisions 885/QD-TTg and 300/QD-

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TTg). The Participatory Guarantee System (PGS) has emerged as a promising approach for promoting organic agriculture. The PGS is a community-based certification system that allows farmers to verify each other's adherence to organic production standards and profit (Böttinger, 2019; Grovermann *et al*., 2024; Tu Tuyet and Whitney, 2017). However, the economic performance of PGS organic farms in Vietnam appears to be mixed. While some farms thrive and command premium prices for their organic produce, others struggle to achieve profitability.

This study explores the economic performance of PGS organic farms in North Vietnam. In addition, factors that differentiate successful farms from those facing economic challenges are also identified by analyzing the determinants. This research provides valuable insights for farmers, policymakers, and stakeholders involved in the PGS organic system with the cabbage farms system as a case study in Vietnam.

MATERIALS AND METHODS

***Sampling*:** This paper used cross-sectional data, which has collected a research area in peri-urban areas around Hanoi and two nearby provinces, Ha Nam and Hoa Binh.

A cluster random sampling approach determined the sample size, including organic PGS-certified and conventional farms (Endalew *et al*., 2024). Regarding PGS-certified farms, 80% of those surveyed (149 households) held PGS certification in the peri-urban area of three provinces. Among conventional farms, the study employed a two-stage sampling method. The first stage involved selecting communes and villages from nine vegetable-producing areas. Villages with at least 50 cabbage producers known to receive support from extension staff were then identified. In the second stage, 20 farmers were chosen at random from each of these villages, with a final selection of 10-14 farmers determined by availability. This resulted in interviews with 119 PGS-certified and 301 traditional farmers from 26 villages in nine districts.

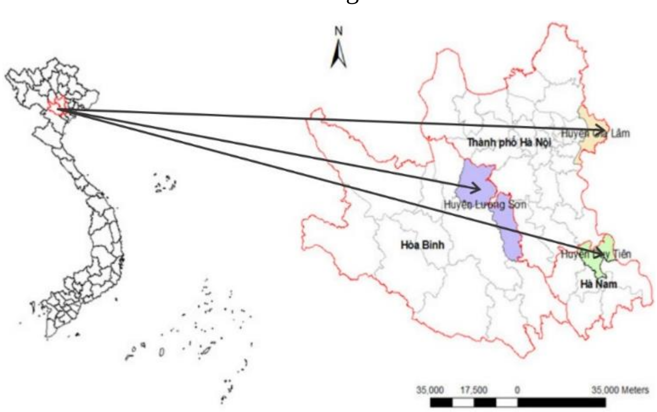

Figure 1. The research site

***Economic assessment*:** Vegetable revenue and costs were calculated for the autumn/winter of 2022/2023. The economic indicators were computed as follows (Commission, 2016)

Gross Output (GO) represents the value of all goods produced by the farm.

$$\mathrm{GO} = \text{Total production x Average selling price (farmgate price)}$$

Intermediate cost (IC) helps determine the input costs necessary to produce the farm's output, serving as the basis for calculating value added and net income, including cash cost (Purchased seed, Fertilizer, Pesticide, Fuel, Paid labor, Machinery, etc) and Land cost.

$$\mathrm{IC} = \text{Cash cost} + \text{Land cost}$$

Value Added is useful for assessing how much value is generated from production activities after deducting input costs.

$$\text{Value Added (VA)} = \mathrm{GO} - \mathrm{IC}$$

Net Farm Income (NFI) shows the actual earnings of the farm and is a key indicator for financial sustainability. It allows farmers to understand the farm's profit after all production-related costs.

$$\text{Net Farm Income (NFI)} = \mathrm{VA} - \text{Paid labor} - \text{Interest cost}$$

$$\text{Labor productivity} = \frac{\mathrm{GO}}{\text{Total Labor cost}}$$

***Discriminant analysis*:** Discriminant analysis (DA) is a statistical approach that divides data points into specified categories. It is useful when the dependent variable (the criterion factor) is categorical, and several independent variables can impact group membership. Unlike other methods, DA does not necessitate a thorough grasp of the correlations between these variables beforehand. DA seeks to identify linear combinations of independent variables, known as discriminant functions, that best separate the various groups. These functions are calculated by maximizing the differences between groups and reducing the variation within each group. This technique enables DA to forecast the group membership of new data points depending on the values of their independent factors.

In other words, Discriminant analysis is a powerful statistical technique used to classify objects or individuals into distinct groups (Ayinla *et al*., 2021). These groups are mutually exclusive, meaning an object can only belong to one group at a time, and exhaustive, meaning all possible categories are accounted for. The classification is based on a set of measurable features, often called variables, that describe the characteristics of the objects or individuals being studied. In essence, we use the observed values of these variables to determine the most likely group membership for each object.

Discriminant analysis typically requires a categorical dependent variable, or nominal variable, that defines the groups. The independent variables can vary, including nominal, ordinal, interval, or ratio types, but are often most effective when continuous **(**Brown and Brown, 1998**;** Klecka,

Variable selection for discriminant analysis

Table 1. Frequency and definition of predictors used in the study.

Variables	Indicators	Type	Value	Farm types		Sig.
				Failure N =50	Success N=69	
Farm profile	Gross Output (Million VND per ha) (GO)	2	Average	290,987	565,701	0.00
	Production cost (Million VND per ha) (PC)	2	Average	109,682	59,957	0.00
	Market access* (MA) (1= Local wet market)	1	% of 1	54.0	33.0	0.01
	Vegetable waste (kg/ha) (VW)	2	Average	32.0	16.0	0.02
Farmer characteristics	Feeling of intercropped application (1= Fairly confident) (A1)	1	% of 1	78.0	94.2	-
	The feeling of the practice of rotation with legumes (A2) (1= Fairly confident)	1	% of 1	62.0	81.0	-
	The feeling of mulching practice (A3) (1= Fairly confident)	1	% of 1	64.0	87.0	-
	The feeling of cover crops and minimal soil disturbance (A4) (1= Fairly confident)	1	% of 1	18.0	46.0	-
	The feeling of pest resistance/improved varieties (1= Fairly confident) (A5)	1	% of 1	14.0	20.0	-
	Involved family people (People) (IP)	2	Average	2.0	2.6	0.02

Code type 1, the binary indicators where the value is 0 or 1; and type 2, continuous indicators (value)
Source: Surveyed data, 2023

1980**).** Overall, discriminant analysis serves as a valuable tool for accurately predicting group membership based on measurable characteristics, with applications across numerous fields.

Discriminant Function is a linear combination of the predictor variables. For two-group classification, the function has the form:

$$D = W_1X_1 + W_2X_2 + \dots . W_kX_k + a$$

where W {1, 2, …, k} are discriminant coefficients/scores, X are predictors variables (farm profile and characteristics) {1, 2, …, k}, and a is a constant.

After the discriminant function is determined, new observations are classified based on group's function value is prosperous farms. In DA, the decision boundary is a line (or hyperplane in higher dimensions) that best separates the groups.

An empirical framework for farm classification**:** According to the main objectives, the study endeavors to draw the characteristics of prosperous farmers in farm management. In other words, the main factors that affect farm profitability are found by examining differences among two group categories, including (failure farm management group: Profit <0; Profit >1 (successful group (No case of profit =0)), thanks to using the DA. This criterion was used as a variable in the discriminant model and assigned a value of 1 if the farmer had positive profitability and 0 otherwise. In other words, farmers were classified into two groups as follows:

Group 1: Prosperous farms

Group 2: Un-prosperous farms

Many previous studies found that farm holding, and farmers' characteristics are associated with farm management. In more detail, farming factors (i.e., farm revenue, farm experience, production cost, farm ownership) and landowner profiles (gender, age, educational level, training, and experience in farm management) affected farm management (Abadi *et al*., 2020; Bizimana *et al*., 2002; Marey-Pérez and Rodríguez-Vicente, 2011; Thuy *et al*., 2020). In other words, two aspects of farm profile and farmers' characteristics are used to measure the impact of farm performance.

Statistical analysis: The study used a T-test sample to compare the economic indicators between two groups of vegetable farms.

RESULTS AND DISCUSSION

Economic performance of vegetable farms: Table 2 describes the cost and benefit analysis of PGS farms by comparison with conventional farms. In detail, PGS and conventional groups' productivity was approximately 30.3 and 48.5 tons per ha, respectively, with significant differences ($p<0.05$). In other words, the PGS farm seems to obtain a lower yield than the conventional one, reducing 18.2 tons per ha. The unoptimized yield of organic production is mainly due to the non-application of fertilizer, synthetic pesticides, and regulation growth. As per previous evidence, excessive synthetic pesticide application could surpass the economic optimum (Hoi *et al*., 2016; Meemken and Qaim, 2018; Schreinemachers *et al*., 2015).

Fortunately, thanks to the price premiums, PGS farmers seem to have two times larger gross output than conventional groups, accounting for over 450 million VND per ha. As per the surveyed data, most PGS vegetables were sold via cooperative (farmers group leaders as traders collected vegetables from individual farmers to transport to retailers in

Table 2. Comparison of economic performance between organic and conventional production groups.
Unit: Million VND per Ha.

Items	PGS (N=119)		Conventional group (N=301)	
	Mean	SD	Mean	SD
Productivity (ton/ha)***	30.3	15.8	48.5	20.4
Gross output (1000 VND/kg)***	450.3	257.7	270.4	164.2
Farmgate price (1000 VND/Kg) ***	14.7	2.2	5.9	2.6
IC (1000 VND/Kg)N/S	80.8	80.0	456.7	5,051.0
VA (1000 VND/Kg) ***	369.4	278.6	-186.3	5,053.7
Hired labor cost (1000 VND/Kg)N/S	1.5	9.7	1.6	15.2
NFI (1000 VND/Kg) ***	367.8	279.5	-187.9	5,053.6
Family labor cost (1000 VND/Kg) ***	426.7	401.9	230.9	796.9
Profit or loss (1000 VND/Kg) N/S	-58.8	511.6	-418.8	5,158.2
Labor productivity***	421.0	322.0	702.0	656.0

Note: ***, **, *, and N/S indicate the statistical significance at the 1%, 5%, and 10% levels and are insignificant in the Kruskal Wallis Test, respectively. Hire labor person-day = 250.000 VND per day. The cost is only calculated using cash from households.
Source: Surveyed data, 2023

Hanoi), while conventional farmers often sell their products via distributors. It is considered that PGS farmers have a niche market with new opportunities for their products.

In addition, because of cost reduction under the PGS standard, especially the elimination of the use of synthetic pesticides,

In addition, value added and NFI of PGS systems were also more extensive than the conventional ones ($p<0.01$). Notably, a gain of 368 million PGS was reported, while a loss of 187 million VND per ha in NFI for the conventional group was reported. This is explained that under the PGS standard, the elimination of the use of synthetic pesticides. The result related to (Grovermann et al. 2024) that PGS farmers could obtain 117% of gross margin as compared with conventional farms. It implies that the value chain for PGS producers may be more productive than the conventional one. On the contrary, in terms of traditional farms, it seems like these farmers were unprosperous in their production and suffered losses of economic benefits. They were highly productive due to low selling prices and highly input-intensive (Table 2) (Martín-García *et al*., 2024). The higher yield in conventional farming could not offset the low selling prices.

Regarding labor cost, there was a significant difference in labor returns between PGS and conventional farms. This fact implies that PGS systems were more labor-intensive, with an increase of around 200 million VND per ha compared with conventional ones. Organic farmers invest more person-day due to manual activities such as hand-weeding, picking and destroying insects, covering crops, etc which correlated Grovermann *et al*. (2024) with the fact that there was no significant effect on returns to labor for PGS farms. Therefore, solutions to reduce labor costs must be considered to improve labor productivity for PGS farms, such as integrated pest management (IPM).

Moreover, to spread the PGS organic farms, the availability and affordability of labor in the region must be considered an economic incentive system in the coming years. On the other side, the higher family labor cost of PGS implies that organic certificate production seems to create more jobs for the family labor, especially women involvement thanks to more power and more engagement in the decision-making of the family (Women comprised the majority of respondents in this survey, accounting for 63% of participants**)** (Home *et al*., 2017). In other words, organic farming may present more significant employment and community development opportunities than conventional agriculture (Finley *et al*., 2018).

Estimating the discriminates affecting the profitability of PGS farms**:** The discriminant function analysis (DFA) with a test sample of 119 organic PGS farmers employed backward stepwise selection, which iteratively removes the variable that weakens the distinction between groups the most (based on Wilks' Lambda) (Table 3). The analysis identified factors affecting profitability between the two categories.

The result revealed ten key factors significantly distinguishing prosperous farmers from non-prosperous farmers. These factors were incorporated into a canonical discriminant function, separating the two groups. In other words, it would be reasonable to develop a profile of the two groups in terms of the ten predictors that seem to be the most important. Thus, a canonical discriminant function that displayed how successful and other unsuccessful farmers could be differentiated in the study region.

The results of the discriminant analysis, including the canonical correlation and Wilk's Lambda test, are presented in Table 3. In this model, the Wilks' Lambda is 0.55, indicating the model is good (a low value closer to 0 reflects better discrimination power of the model). In other words, the analysis revealed a solid discriminatory power, with the first eigenvalue indicating that the discriminant function explains a high proportion of the total variance (approximately 83 %). However, Wilk's Lambda test also suggests that there is still a significant amount of unexplained variance (around 30%) in

Table 3. Results of the discriminant analysis applied with the backward stepwise selection procedure.

Variables	Indicators	Wilks' Lambda	F	df1	df2
Farm profile	Gross Output (GO)	0.720774	45.32***	1	117
	Production cost (PC)	0.905156	12.25***	1	117
	Market access (MA)	0.957289	5.22**	1	117
	Vegetable waste (VW)	0.960002	4.87**	1	117
Farmer characteristics	Feeling of Intercropped application (A1)	0.954432	5.58**	1	117
	The feeling of the practice of rotation with legumes (A2)	0.964738	4.27**	1	117
	The feeling of mulching practice (A3)	0.945739	6.71**	1	117
	The feeling of cover crops and minimal soil disturbance (A4)	0.873333	16.96***	1	117
	The feeling of pest-resistant/improved varieties (A5)	0.970048	3.61**	1	117
	Involved people (IP)	7.354970	7.35***	1	117

Eigenvalue: 0.83
Canonical Correlation: 0.67
Wilks Lambda: 0.55
Percentage of Variance: 100
Cumulative percentage: 100
Chi-square: 67.8
Df: 10
P value = 0.00

Note: The significance levels are indicated as ****p <0.10, **p <0.05,
Source: Surveyed data 2023

the discriminant scores. This finding indicates that while the model can effectively discriminate between groups, other factors may influence the data that the current model does not capture.

Moreover, the differentiation between farmer groups was assessed with the standardized coefficient of the canonical discriminant function (Table 4). Accordingly, Gross Output (GO) had the highest impact on prosperous farms. The critical factors were A1, A3, MA, PC, and IP. With a similar effect on the discriminant function, A5, A4, VW, and A2, they also differed significantly between the two groups.

The positive sign of the coefficient for GO, A1, A3, A4, and A5 indicated that higher Gross Output, confident feeling adoption of cover crops and minimal soil disturbance, fairly confident feeling adoption of intercropping practice, practice of rotation with legumes and practice of pest-resistant or other improved varieties would be associated with higher discriminant scores. On the contrary, the negative signs of the coefficient of PC, A2, IP, MA, and VW mean that higher productive cost, fairy feeling of mulching practice, higher quantity of post-harvest losses, more extensive family units, and direct market access would be related to lower discriminant scores (Table 4). For instance, VW (coefficient =-0.13) has a negative coefficient, indicating that higher levels of vegetable waste per hectare are associated with the group having negative profit. Excess vegetable waste could signify inefficiencies in production or post-harvest processes, which can lead to lower profitability. Thus, reducing waste might improve efficiency and profitability, potentially shifting towards the positive profit group. The predictors correlation and the discriminant function are presented in Table 4, which shows the significant impacts of factors on successful farms. Accordingly, the successful farms' criterion variable was described as positive and strong, mainly dominated by the gross output predictor in the study region (correlation of 0.68). This implies that gross output is considered the most critical factor in group discrimination. In addition, the correlation values of the degree of A1 (0.42) and farm status criterion also showed that the discriminant function distinguished, although moderately, between success farmers and non-success farmers in the area. Finally, PC, IP, A2, A3, MA, VW, A4, and A5 predictors were positively and weakly correlated with the farm status criterion variable (Table 4). In terms of correlation with success farming, six predictors integrated into the canonical discriminant function, including GO, A1, A2, A3, A4, and A5, were more likely to be categorized as such. This implied that higher values for (1) GO, (2) adoption of cover crops and low soil disturbance, (3) adoption of mulching practice, (4) adoption of intercropping practice, (5) adoption of legume rotation practice, and (6) pest-resistant or other enhanced varieties had a beneficial effect on prosperous farms. This data suggests that gross output remains the most crucial element in success. Furthermore, supporting and boosting farmers' confidence in using cover crops, limited tillage, intercropping, legume rotation, and better varieties should be addressed. PC, IP, MA, and VW, the remaining four predictors in the canonical discriminant function, were all negative and had a weak correlation with success farms. This indicates that the higher the production cost, the more family laborers there are, the more direct market access there is, and the greater the number of post-harvest losses due to pests and returned produce, the

less successful the farm is. Furthermore, excessive expenses harm success, and prioritizing efficient resource utilization as a driver may be associated with farmer failure. This fact means that measures to improve yields and resource usage efficiency remain critical, as well as cost structure analysis, cost-cutting practices in areas such as fertilizer and pesticide use, and alternative labor options if family labor is a big cost element. Furthermore, bypassing local wet markets may result in higher profits for farmers because vegetable distribution allows farmers to establish relationships with shops and restaurants, potentially gaining better insights into market demands and pricing or negotiating based on their produce's quality or unique characteristics. This can be especially useful for farms that produce high-quality or niche products. This allows businesses to adapt their production accordingly and potentially fetch more excellent pricing.

The study found that successful farms use sustainable methods such as cover crops, low tillage, improved varieties, intercropping, and legume rotation. Even though they require some initial investment, these strategies have the potential to improve soil health, reduce pest problems, and raise yields in the long run.

Table 4. Standardized coefficients of the canonical discriminant function. Structure matrix: correlation between predictors and the discriminant function.

Variable	Coefficient	Correlation
Gross Output (Million VND per ha)	0.70	0.68
The feeling of cover crops and minimal soil disturbance (A1)	0.38	0.42
Productive cost (PC)	-0.32	-0.35
Involved people in vegetable farm (IP)	-0.28	-0.27
The feeling of mulching practice (A2)	-0.01	0.26
Feeling of Intercropped practice (A3)	0.09	0.24
Market access (MA)	-0.33	-0.23
Vegetable waste (kg/ha) VW	-0.13	-0.22
The feeling of the practice of rotation with legumes (A4)	0.05	0.21
The feeling of pest resistance or improved variety (A5)	0.16	0.19

Source: Surveyed data 2023

***Conclusion*:** This paper compares the economic benefits of PGS organic and conventional farms in Northern Vietnam and identifies key factors for successful farming. Results show that PGS organic farming offers significant economic advantages, including lower intermediate costs and premium prices, but remains labor-intensive with limited labor returns. To maximize profitability, market access and technology innovation are essential, along with sustainable practices such as cover cropping, mulching, intercropping, and rotation with legumes. Effective cost management and waste reduction further enhance economic viability. Agricultural policies that reduce costs and support a safe vegetable value chain will continue to influence organic farming's profitability. By understanding these factors, farmers can improve their competitiveness, while local governments should prioritize training programs to equip PGS farmers with efficient production and marketing skills.

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